

## ARRANGEMENT FOR DATA TRANSMISSION IN MINE, AND CABLE REEL

### BACKGROUND OF THE INVENTION

[0001] The invention relates to an arrangement for data transmission in a mine or the like, the arrangement comprising: an mine information system consisting of at least a control unit of the mine; a mining vehicle information system consisting of at least a control unit of the mining vehicle; at least one supply cable that comprises at least one data transmission cable and is arranged to transmit data between the information system of the mine and the information system of the mining vehicle, and the first end of the supply cable is connected to the information system of the mine; a reel arranged in the mining vehicle and having a drum rotatable around its centre axis for storing the supply cable in the mining vehicle; means for connecting the second end of the supply cable to the reel drum; and connecting means for connecting the data transmission cable in the supply cable from the rotating drum to the information system of the mining vehicle.

[0002] The invention further relates to a cable reel for storing the supply cable of a mining vehicle, the reel comprising: a drum, on the outer surface of which the supply cable can be wound; a first end and a second end of the drum; a centre axis around which the drum is rotated; and connection means for connecting at least one data transmission cable in the supply cable to an information system external to the reel.

[0003] Both manned and unmanned mining vehicles are used in mines. Bidirectional data transmission is required between the mining vehicle and the control room of the mine so as to be able to give control commands to the mining vehicle and so that mining vehicles can transmit information on their locations and the tasks they perform to the control room. The bidirectional data transmission between the information systems of the mining vehicle and mine can take place by means of one data transmission cable. However, the limited data transmission capacity of the data transmission cable then creates a problem. In addition, bidirectional data transmission in one cable requires complex devices to arrange.

### BRIEF DESCRIPTION OF THE INVENTION

[0004] It is an object of the present invention to provide a novel and improved arrangement for data transmission in a mine, and a cable reel.

**[0005]** The arrangement of the invention is characterized in that the supply cable has at least a first data transmission cable for transmitting data unidirectionally from the information system of the mine to the information system of the mining vehicle, and a second data transmission cable for unidirectional data transmission from the information system of the mining vehicle to the information system of the mine; that said connection means comprise a first rotating connection element on the first end of the drum, and a second rotating connection element on the second end of the drum; that the rotating connection elements are arranged on the centre axis of the drum; that the rotating connection element comprises a rotor and a stator, and the rotor is arranged to rotate with the drum around the centre axis and the stator is arranged non-rotatable; that the rotor of the first rotating connection element is connected to the first data transmission cable of the supply cable, and the stator is connected to the information system of the mining vehicle; and that the rotor of the second rotating connection element is connected to the second data transmission cable of the supply cable, and the stator is connected to the information system of the mining vehicle.

**[0006]** The cable reel of the invention is characterized in that the supply cable has a first data transmission cable for data transmission and a second data transmission cable for data transmission; that the first end of the drum has a first rotating connection element; that the second end of the drum has a second rotating connection element; that the rotating connection elements are arranged on the centre axis of the drum; that the rotating connection element comprises a rotor and a stator, with the rotor arranged to rotate with the drum around the centre axis and the stator arranged non-rotatable; that the rotor of the first rotating connection element is connected to the first data transmission cable of the supply cable, and the stator is connected to the information system of the mining vehicle; and that the rotor of the second rotating connection element is connected to the second data transmission cable of the supply cable, and the stator is connected to the information system of the mining vehicle.

**[0007]** The essential idea of the invention is that data transmission between the information system of the mine and the information system of the mining vehicle is arranged using two unidirectional data transmission cables. Information is transmitted from the information system of the mine to the information system of the mining vehicle over the first cable, and data transmission

in the opposite direction takes place over the second cable. The data transmission cables are arranged in the supply cable that can be stored on a reel in the mining vehicle. The reel has a rotatable drum on which the supply cable can be wound. The first end of the drum has a first rotating connection element for connecting the first data transmission cable to the information system of the mining vehicle. Correspondingly, the second end of the drum has a second rotating connection element for connecting the second data transmission cable to the information system of the mining vehicle. The rotating connection element comprises a rotor and a stator, with the rotor arranged to rotate with the drum and the stator arranged non-rotatable. Further, the rotor is connected to one data transmission cable in the supply cable, and the stator is connected to the information system of the mining vehicle.

**[0008]** An advantage of the invention is that bidirectional data transmission between the information system of the mining vehicle and the information system of the mine can be implemented using two unidirectional data transmission cables that can be arranged inside the supply cable. Because information is transmitted in the data transmission cable in one direction only, it is possible to transmit very large amounts of data without problems. Further, when a reel equipped with the rotating connection elements of the invention is used, the unidirectional data transmission cables can be connected in a relatively simple manner to the information system of the mining vehicle.

**[0009]** An essential idea of an embodiment of the invention is to use two optical fibre cables, a first optical fibre cable to transmit data from the information system of the mine to the information system of the mining vehicle and a second optical fibre cable for data transmission in the opposite direction.

**[0010]** An essential idea of an embodiment of the invention is that the rotating connection element is an optical cable connector.

**[0011]** An essential idea of an embodiment of the invention is that the supply cable has more than two data transmission cables and that only two data transmission cables at a time are connected to the information system. Then the supply cable has extra data transmission cables in reserve. If one of the used data transmission cables is damaged, the damaged cable can be replaced by connecting an inactive extra data transmission cable for use.

**[0012]** An essential idea of an embodiment of the invention is that the supply cable comprises at least one electric supply cable. In such a case, power transmission means are arranged to the reel drum to set up an electric

connection between the electric supply cable and the electric system of the mining vehicle.

#### BRIEF DESCRIPTION OF THE FIGURES

**[0013]** The invention is described in more detail in the attached drawings, in which

Figure 1 is a schematic representation of an arrangement of the invention in a mine,

Figure 2 is a schematic cross-sectional representation of a section of a supply cable,

Figure 3 is a schematic top view of a cable reel of the invention, and

Figure 4 is a schematic side view of a rotating connection element.

**[0014]** In the figures, the invention is shown in a simplified manner for the sake of clarity. Where possible, similar parts are marked with the same reference numbers in the figures.

#### DETAILED DESCRIPTION OF SOME EMBODIMENTS OF THE INVENTION

**[0015]** Figure 1 shows an arrangement of the invention. The mining vehicle 1 can be a loading vehicle like the one shown in Figure 1, or it may be a rock drilling rig, transport vehicle or the like. The mining vehicle 1 can be electrically driven, in which case it is connected by a supply cable 2 to the electrical power network 3 of the mine. One end of the supply cable 2 can be connected to a connection unit 4 arranged in the mine, and the other end of the cable can be connected to a reel 5 in the mining vehicle 1. The reel 5 is arranged rotatable relative to its axis 6 so that a required amount of supply cable 2 can be wound around the reel 5. The reel 5 can have power transmission means, such as slip rings or the like, by means of which electric conductors in the supply cable 2 can be connected to the electric system 7 of the mining vehicle 1 that conducts electric current on to a motor 8 and other electric devices in the mining vehicle 1. Means for affecting the rotation of the reel 5 may belong to it or be arranged to it.

**[0016]** It should be mentioned that in this application, a mine refers to both surface and underground mines, quarries and the like, as well as tunnels and other work sites.

**[0017]** The mining vehicle 1 may be manned or unmanned. An unmanned mining vehicle may be arranged to run automatically in the mine by its own navigation system, or alternatively there may be identifiers in the mine and

the mining vehicle 1 navigates in the mine by reading them. Further, an unmanned mining vehicle 1 may be guided by remote control from a control room 9. In such a case, the mining vehicle 1 has one or more cameras 10 and measuring devices 11 that transmit information to the control room 9. On the basis of the received information, the operator can give control commands to the mining vehicle. Two-way data transmission is then required between the mining vehicle 1 and the control room 9. Two-way data transmission is also required when using automatic mining vehicles, because unmanned mining vehicles 1 should transmit information of their location and the tasks they have performed so that the mining vehicles 1 can be monitored. In addition, new tasks and updates can be transmitted to the mining vehicles during operation.

**[0018]** A mining vehicle 1 can have an information system that comprises a control unit 12. The mine further has a control unit 13 that may be part of the information system of the mine. There may be two-way data transmission between the control units 12 and 13, based on the utilization of two data transmission cables arranged for one-way data transmission. The data transmission cables may be optical fibre cables arranged in the supply cable. Each optical fibre cable in the supply cable 2 is arranged to transmit data in one direction only. The first optical fibre cable is then arranged to transmit data from the control unit 13 of the mine to the control unit 12 in the mining vehicle, and the second optical fibre cable is arranged to transmit data in the opposite direction. Because the optical fibre cable is used in one-way data transmission only, it may have a high data transmission capacity. The control unit 13 of the mine may be connected to the connection unit 4, to which the supply cable 2 can be connected.

**[0019]** Figure 2 shows in cross-section a section of a supply cable 2. The supply cable 2 may comprise a protective cover 14 inside which an electric supply cable 15 and a first optical fibre cable 16 and a second optical fibre cable 17 may be arranged. If necessary, the supply cable 2 may comprise extra optical fibre cables 18 and 19 that may be taken into use if the used optical fibre cable 16 or 17 is damaged. The space between the protective cover 14 and the cables 15 to 19 can be filled with a suitable protective or isolation material.

**[0020]** Figure 3 is a top view of the reel 5 of the invention. Figure 3 is simplified for the sake of clarity. The reel 5 may comprise a drum 20 that is turnable relative to the centre axis 21. The drum 20 may comprise a cylindrical



mantle or it may comprise one or more other surfaces around which the supply cable 2 can be wound and respectively unwound by turning the drum 20. The opposite ends of the drum 20 may have end flanges 22. The reel 5 may further comprise a rotating device 23 that rotates the drum 20 by means of transmission elements 24 in direction A. When the mining vehicle 1 moves in direction B, the reel 5 may release the supply cable 2 or store it. The drum 20 may be mounted by bearings 25 on the mining vehicle 1. The first end of the supply cable 2 may be connected to the connection unit 4 and the second end may be connected to the drum 20. Inside the drum 20, the various cables 15 to 17 in the supply cable 2 can be separated and led to the ends of the drum 20. At the second end of the supply cable 5, the electric supply cable 15 is connected by means of power transmission means 26 to the electric system 7 of the mining vehicle 1. The power transmission unit 26 may comprise a slip ring or the like to enable electric supply from a rotating drum 20 to the electric system 7. Further, the first optical fibre cable 16 can be led to a first rotating connection element 27 at the first end of the drum 20, and correspondingly the second optical fibre cable 17 can be led to a second rotating connection element 28 at the second end of the drum 20. By means of the rotating connection elements 27 and 28, the optical fibre cables 16 and 17 rotating with the drum 20 can be connected to the non-rotating data transmission cables 29 and 30 or the like that are in the mining vehicle 1 and are part of the information system of the mining vehicle. It is also possible to form one or more connecting cables and parts inside the drum 20 between the second end of the supply cable 2 and the rotating connection element 27, 28. Correspondingly, in connection with the drum 20, there may be one or more conductor elements between the second end of the supply cable and the power transmission means 26.

[0021] Figure 4 illustrates a rotating connection element 27. The rotating connection element 27 may comprise a rotor 31 arranged to rotate in direction A around the axis 21 together with the drum 20. Further, the connection element 27 may comprise a stator 32 fastened non-rotatably relative to the body 33 of the mining vehicle 1. The optical light cable 29 leading to the control unit 12 of the mining vehicle 1 can be connected to the stator 32 and the optical light cable 16 on the drum 20 can be connected to the rotor 31. The rotating connection elements 27, 28 are arranged coaxial to the drum 20.

**[0022]** It should be noted that it is also possible to use any other data transmission cable intended for one-way data transmission instead of an optical fibre cable.

**[0023]** Further, in some cases the cable reel of the invention can also be used with data transmission cables adapted for two-way data transmission.

**[0024]** The drawings and the related description are only intended to illustrate the idea of the invention. The invention may vary in detail within the scope of the claims.